be used to provide information to FCC on future actions. The USFWS suggests that agency involvement in such research is important.

Regarding communication tower research programs, cost for such research, and appropriate parties who should carry out the needed research, only the USFWS provided comments on the estimated cost for conducting research. The estimated cost for a nationwide 3-year study of 250 towers was $15 to 20 million. They recommended that FCC participate in this funding effort.

3.3.9 Mitigation Approaches

3.3.9.1 NOI Questions

- *29. We seek comment on whether existing studies or research address the use of particular methods to minimize any impact of communications towers on migratory birds.*

3.3.9.2 General Responses and Summaries

FCC sought comment on these issues but few specific comments were provided by the respondents. Based on the reviews of the NOI comments and available literature, not enough is known to recommend different types of mitigation for mortality. Studies are presently ongoing that may suggest possible mitigation strategies. A review of the transmission line and wind turbine literature on bird mortality and mitigation could provide possible directions for mitigation research in addition to the Communication Tower Working Group's recommendations, specifically the Research Subcommittee. Section 4.2 contains an overview of the devices and approaches that are presently being used on overhead wires specific to the electric utility industry. Applying these types of devices to guy wires on communication towers would need to be examined further. Specifically, the majority of these devices have not been specifically designed to address nocturnal migrant bird collisions.

As stated in the Section 4.2 discussion, wire marking is not a perfect solution for the power line industry, nor would it be expected to completely resolve avian collision issues at communication tower sites. Presently, it is unknown whether this approach would result in: 1) operational problems for the broadcasting company, 2) public opposition from an aesthetics perspective, and 3) a decrease in bird collisions and associated mortalities. Ongoing communications among the FCC, communication industry, avian researchers, the public, and other interested stakeholders are necessary to identify appropriate future options and approaches to test.

3.3.9.3 Specific Respondent Comments

The American Bird Conservancy, Forest Conservation Council, and the Friends of the Earth provided recommendations for minimizing avian collisions at communication tower sites, which coincide with the USFWS' tower siting guidelines (USFWS 2000). These options included: 1) collocate facilities to minimize the number of new towers in new areas; 2) construct towers <199 feet to avoid using guy wires and the FAA lighting requirement; 3) use white (preferably) or red strobe lights, avoiding the use of solid red or pulsating (beacon) red lights; 4) use downshielded security lighting; 5) install daytime visual markers on guy wires in areas with raptors or waterfowl or with other diurnal movement routes for birds; 6) implement proper tower siting; and 7) develop appropriate survey methods. However, no specific details were provided on how these specific recommendations were developed.

3.3.10 Mortality Patterns

3.3.10.1 NOI Questions

- *We seek comment on the extent of migratory bird deaths that may be attributable to collisions with communications towers, the species and geographic locations involved, and what the raw numbers mean in terms of survival of species or in other relevant contexts.*

A discussion of the impact of communication towers on the mortality of migrating birds has been provided previously in Sections 3.2.3 and 3.2.4. The reader is referred to these sections for a more thorough review.

3.3.10.2 General Responses and Summaries

To a certain degree, the respondents addressed some mortality patterns, including the type of species more frequently affected; the seasonality of the mortality, and the magnitude of the mortality. Additional research on bird species most affected by tower collisions and why they are more susceptible is needed. Information on other factors, such as seasonality and magnitude, also would be valuable and could be incorporated into the appropriate study design.

3.3.10.3 Specific Respondent Comments

CTIA concluded causes of mortality are unknown. Woodlot stated that given the limitation of studies, the magnitude of mortality estimates are probably underestimated; declines in mortality over time at a site have been documented but the reasons are unknown. Mass mortality does occur but is an infrequent event. Woodlot further states mass mortalities can result in a substantial impact on the total number of birds killed in a subpopulation.

In their mortality summary, the American Bird Conservancy, Forest Conservation Council, and the Friends of the Earth characterize these mortalities as "sizeable kills," "regularly" occurring, and occurring in "North America."

3.3.11 New Information

3.3.11.1 NOI Questions

The FCC sought new information available on avian interactions with communication towers.

- *We also seek comment on any ongoing or planned studies with which the Commission might coordinate in order to achieve synergies and avoid duplication of effort.*

3.3.11.2 General Responses and Summaries

No new or original scientific research on the impact of towers on migratory birds was provided by the respondents. Overall, the respondents cited literature based on scientific articles by experts in ornithology. Many of the published studies that were cited can be considered to be scientifically acceptable, having gone through a peer review process before publishing. The issue of scientifically acceptable research is more applicable to the interpretation of the results beyond the objectives of the specific studies. The controversy regarding scientifically acceptable and rigorous methodologies relates to developing new conclusions from the previous research (e.g., issues of tower height and mortality).

3.3.11.3 Specific Respondent Comments

CITA, PCIA, and NAB provided no new information on bird collisions and communication towers. They did provide an updated extensive literature review in the Woodlot Report. PCIA referred to a member survey, requesting mortality information, but no details were given on the survey in order to evaluate it, as outlined and discussed in Section 3.3.1.3.

3.4 CURRENT RESEARCH EFFORTS

3.4.1 Michigan State Police Tower Study

A pilot study was conducted September 2003 on three guyed and three unguyed 479-foot towers owned and operated by the Michigan State Police. A total of 22 bird carcasses were recovered during the 20-day survey, all under the three-guyed towers. Adjusting for surveyor detection bias, an estimated 51 bird mortalities were estimated at the three towers during this 20-day period. A subsequent 2-year (4-season) study began spring of 2004 on 24 towers. Research hypotheses include predictions that guyed towers are riskier than unguyed, blinking lights are more attractive to birds than red strobes, and red strobes are more attractive than white strobes (Communication Tower Working Group Meeting, February 11, 2004, Gehring 2004).

3.4.2 Clear Channel of Northern Colorado Tower Study

One communication tower study was recently completed in the western U.S. This study encompassed a 2-year monitoring project to record bird collisions with the Slab Canyon KQLF broadcasting tower owned and operated by Clear Channel Communications of Northern Colorado. Construction of a 500-foot, lighted, and guyed tower was completed by July 2002, and monitoring efforts began immediately. Because of public opposition to white strobe lights at night, the tower uses white strobe lights during the day and red blinking, incandescent lights at night. The study paralleled the methods used by Avery et al. (1977), recording the incidence of bird mortalities at the tower site and at a reference site along the eastern flank of the Front Range of Colorado. Tower surveys were conducted once per week throughout the year during the 2-year period, with additional surveys completed following storm events during the migration periods. Three remote-control cameras also were periodically used to monitor the remote and rugged site, particularly following storm fronts during migration. The emphasis on using the remotely controlled cameras was to determine whether moderate to significant mortalities may have occurred overnight at the site (i.e., multiple or mass kills). Scavenger removal rates were calculated and surveyor bias was estimated to compensate for birds lost to predators or not observed during the surveys, respectively. Weather patterns are currently being analyzed for the 2-year period. Study results should be available by the end of 2004 (EDM and CSU 2004).

3.4.3 Coconino and Prescott National Forest Tower Study

Another western study is a 3-year monitoring program in Arizona on the Coconino and Prescott National Forests, which was initiated in April 2004. This study will monitor bird mortalities associated with six communication towers located along I-17 south of Flagstaff. All six towers are less than 199 feet above ground level (AGL), unlit, and self-supporting (WEST 2004). American Tower Corporation owns five of the towers and DW Tower owns the sixth.

3.4.4 Philadelphia Tower Study

J. Johnson of Swarthmore College initiated a 3-season radar study of migratory bird behavior near three guyed, lighted communication towers 1,115 to 1,280 feet in height. Using a mobile marine, high-resolution radar scanner, surveyors monitored bird movement up to 1,476 feet in altitude, focusing on inclement weather events. Acoustical monitoring also was conducted to record flight calls. During the 2003 spring period (N=14 nights) and fall period (N=7 nights), a "curvature index" was developed, concluding that not all birds flew in linear, straight lines. Preliminary conclusions suggest that the birds exhibited non-linear flight patterns around tower sites. This will be tested for two more seasons (Communication Tower Working Group Meeting, February 11, 2004).

3.4.5 Mobile Lighting Study

Old Bird Inc. is initiating a ground-based, mobile lighting study to test and compare bird attraction to red incandescent, red strobe, and white strobe lighting. Truck-mounted, portable lights will be illuminated in areas with inclement weather or frontal systems to record bird behavior relative to the different lighting regimes (i.e., color and flash rate). The study will be testing the hypothesis that red wavelengths of light appear to disrupt birds' navigational systems, particularly their magnetic systems used during migration. Acoustical monitoring equipment also will be used to record flight calls and to document the relative degree of bird "congestion" (Communication Tower Working Group Meeting, February 11, 2004).

3.4.6 U.S. Coast Guard "Rescue 21" Study

In support of upgrading and reconfiguring existing communication structures, the U.S. Coast Guard (USCG) and the USFWS have entered into a Memorandum of Understanding (MOU) to examine 20 towers relative to lighting, tower height, guy wires, location, weather, possible collision deterrents and how they relate to birds. This 3-year study is part of the USCG's "Rescue 21" ship-to-shore emergency communication system. The project's start date is currently unknown (Communication Tower Working Group Meeting, February 11, 2004).

3.5 BIOLOGICAL SIGNIFICANCE

3.5.1 Introduction

One common theme that was observed in the NOI replies involves the differing uses of the term "significance." "Significance" can be used in two ways. "Significance" can refer to statistical significance, which involves the probability of obtaining certain results given that a null hypothesis is true. "Significance" also can refer to a biological or ecological value attributed to an individual species or population of biological significance. The following discussion refers to the latter.

Biological significance reflects a combination of both the magnitude of the biological effect and the importance of the biological effect. The magnitude of an effect may be considered high when a large number, percentage or proportion of a population is affected and low when the converse is true. Importance is a judgment based on ecological principles and/or societal values ascribed to a given effect. For example, effects that cause an increase in the normal mortality rate or reduce the normal birth rate for a species resulting in a decline in the local, regional or range-wide populations would be considered biologically important based on principles of population biology. Any effects to a species that society has designated as rare (e.g., threatened or endangered species) also would be considered important.

3.5.2 Summary of Respondents' Comments

A review of the respondents' replies showed that when a respondent discussed the communication tower mortality, the term "significance" was frequently used without defining the context of its use. Both "statistical significance" and "biological significance" were referred to. For example CITA, PCIA, and NAB generalized from statements by USFWS in a summary article on migratory bird mortality (USFWS, 2002. *Migratory Bird Mortality: Many Human Caused Threats Affect Our Bird Populations.* http://birds.fws.gov/mortality-fact-sheet.pdf) and the Woodlot report that since 1) other activities cause greater mortality (e.g., collision with utility structures, automobile strikes, habitat loss, cat predation, etc); 2) the numbers of individuals killed relative to total population numbers are small; and 3) because the information available with which to judge the "significance" of impacts to bird populations is lacking, it is not possible to conclude that collisions with towers have a "biologically significant" adverse effect on migratory bird populations.

The NAB stated that the comparatively small numbers of birds killed in communication tower collisions is not having a material effect in altering migratory bird populations. In addition, CTIA stated that there has been no evidence that communication towers are having a significant effect on migratory bird populations. CTIA and NAB supported these conclusions by comparing communication tower mortality estimates summarized by Woodlot (2003) with other forms of avian mortality such as window collisions, vehicle collisions, transmission lines, pesticides and oil pollution, and domestic cat predation. They stated that avian mortality from all human-related factors is estimated to be approximately 950 million birds annually, out of an estimated 10 to 20 billion migratory bird population. They concluded that compared with other forms of mortality, communication tower collisions are not significant.

Cingular Wireless and SBC Communications also stated the number of birds estimated to die as the result of tower collisions is relatively small. The Woodlot report stated that communication towers are estimated to cause 0.42% of human-caused mortality (approximately, 4 million bird deaths), which represents about 0.05% of the total migratory bird population. No discussion of significance is provided.

PCIA concluded that without documentation (assumed to refer to mortality studies) that a "statistically significant impact" of bird mortality cannot be determined and because of the lack of critical scientific studies, the role that communication towers play in migratory bird mortality cannot be judged.

The USFWS discussed national and regional mortality estimates and concluded that "this level of mortality" (i.e., mortality caused by collisions with communications towers) represents a significant and unacceptable impact on avian populations, particularly warblers (Parulidae), thrushes (Turdidae), and vireos (Vireonidae), which, based on mortality studies, appear to be the most vulnerable. The USFWS used the example of the three-tower, single-night event on January 22, 1998, in western Kansas where 5,000 to 10,000 Lapland longspurs were estimated to have been killed. The USFWS concluded that if tower kills create a biological breeding threshold below which avian species stop breeding then species extinction is possible. In support of this argument, the USFWS stated that a Federally endangered female Kirtland's warbler was retrieved at a 700-foot tower in South Carolina in the fall of 2003. A 2003 survey estimated the total population of singing male Kirtland's warblers at only 1,202 birds. The implication is that any mortality above the natural levels could be considered biologically significant.

The American Bird Conservancy, Forest Conservation Council, and Friends of the Earth do not make specific reference to biological significance but state that communication towers do kill migratory birds and endangered species, implying some importance to this effect. They also cite Shire et al. (2000). This compilation reviewed 149 documents on avian tower kills. An important point discussed in this review and summary is that of 230 species recorded killed in these studies, 52 species are in decline or require special management attention. These 52 species were either on the USFWS' *Nongame Birds of Management Concern List* or the *Partners in Flight Watch List.* Two federally endangered species, the red cockaded woodpecker and Kirtland's warbler, have been found at tower sites.

3.5.3 Other Relevant Information

In November 2003, the National Wind Coordinating Committee (NWCC) held a meeting to discuss "biological significance" as it applies to wind turbine projects (*How is Biological Significance Determined When Assessing Possible Impacts of Onshore Wind Power Facilities?).* Speakers were invited to discuss the term biological significance and its use. The following is a selected list of conclusions of the meeting regarding biological significance that should be applied to communication tower mortality.

Definition of Biological Significance

- A biologically significant effect is an effect that could result in an influence on population viability.

Characteristics of the Term Biological Significance

- Who defines biological significance is important. Biological significance should not be framed by the concerns for a single bird or by a local population.
- Defining biological significance for a population may require examination of the region and habitat for a specific species.

- Biological significance is most useful at a site-specific and regional scale.

- Biological significance needs to consider the following questions: Significant to what? Within what geographic area? Over what time frame?

Accepting Uncertainty in the Definition

- The definition of biological significance needs to include a statement about accepting uncertainty in characterizing biological significance.

- Precise population estimates are not required to assess whether an impact is significant.

Application or Use of Biological Significance

- Biological significance should be used as a tool for assessing significant impacts at a site in permitting processes.

- Use defined criteria for biological significance to evaluate potential sites as to the likelihood of resulting in major impact as compared with other sites (i.e., comparison of areas where important populations of birds migrate, are used as flyways, or are close to threatened species and suitable habitat versus other areas).

A USFWS presentation at the same meeting provided information on the regulatory interpretation to the term biological significance. (A. Manville. 2003. *The MBTA, BGEPA, ESA, NEPA and Migratory Birds – Legal and Ecological Implications in Dealing with Biological Significance*. Available from:

http://www.nationalwind.org/events/wildlife/20031117/presentations/Manville.pdf)

Dr. Manville stated that Division of Migratory Bird Management does not have an accepted definition of "biological significance." The Migratory Bird Treaty Act (MBTA) does not address biological significance and in the Endangered Species Act (ESA), biological significance is only addressed in terms of definitions specific to species status (i.e., their rareness as threatened and endangered species).

Manville indicated that the National Environmental Policy Act (NEPA) addresses "biological significance" but only where a Federal nexus (i.e., Federal action requiring NEPA review) applies. Specifically, significance under NEPA requires consideration of the “context” (i.e., importance) and “intensity”(i.e., magnitude) of the action. The context of an action may include societal (human, national) context as it relates to the affected region, the affected interests, and the locality. Intensity refers to severity of impact.

3.5.4 Conclusions

Biological significance is an important concept that needs to be defined in any discussion regarding the significance of communication tower mortality. As previously noted, biologically significant mortality is any mortality that is of sufficient magnitude and importance that it causes the viability of a particular population or species to be affected. It also needs to be defined in the context of a particular species or population of a species to which it is being applied. Precise population estimates are not needed to assess whether an impact is significant. Because of the variability of a species and site conditions some uncertainty needs to be accepted in determining significance.

In estimating and characterizing the impact of communication towers on avian populations, our knowledge of biological factors critical to the development of predictive impacts is simply not adequately developed to draw specific conclusions on the effects to migratory bird populations as a whole and possibly to specific species. It is established that communication towers cause mortality to migratory bird populations. In some instances this mortality can be very large (i.e., hundred to thousands of birds) in mass mortality events.

The issue with migratory birds is complex both in terms of what species are being referred to as well as their status. The challenge in developing more confident estimates of population change resulting from telecommunication mortality is that it is fundamentally difficult to demonstrate for many species of migrant birds that any ‘particular’ kind of stress causes a reduction in migratory bird population size. The observed decline in migratory birds as a group and individual species is a cumulative response to various factors. It is recognized that bird populations are perpetually in flux for numerous reasons, so determining a baseline population size, then detecting a trend, and then determining if a trend is a significant deviation from an existing baseline or is simply an expected fluctuation around a stable equilibrium is problematic in many cases. However, some bird populations are well studied such as the Kirtland's warbler and red cockaded woodpecker, and sufficient information is available to determine the contribution of one stress or another on the population's viability. In these instances an analysis of biological significance is possible.

SECTION 4
DATA NEEDS AND MITIGATION METHODS

4.1 GOING FORWARD AND DATA NEEDS

The following discussion focuses on specific areas or approaches that may aid in answering some of the outstanding questions pertaining to bird collision risks with communication towers.

4.1.1 Standardized Methods and Metrics

When examining the studies and incidental reporting of bird mortalities within the last 50 years, it is apparent that few data have been collected with a standard, systematic process. One of the more important aspects for planning future studies on bird interactions with communication towers is to develop a system of standardized methods and metrics for finding and reporting bird mortalities. These standards would allow comparisons among studies in order to develop consistent conclusions and identify possible mitigation approaches. Kerlinger (2000b) outlines the necessary components of developing standard methods and metrics, as done in the windpower industry for determining avian collisions with wind turbine units. He emphasizes that these need to be established in order to begin measurements and applicable comparisons.

The Communication Tower Working Group's Research Subcommittee has developed an *Integrated Nationwide Research Proposal - "Causes and Solutions to Bird Strikes at Communication Towers,"* dated April 14, 2000. This resource and associated dialog would provide a basis for standardizing applicable study methods.

Meyers (2000) and Kerlinger (2000b) both discuss the value of establishing well designed, scientifically based methods that standardize the studies to answer some of the unknowns. However, in the interim, Myers (2000) also argues that biologists and regulatory agencies need information in the near term, in order to make decisions and determine an applicable course of action (i.e., "adaptive management").

4.1.2 Species-specific Susceptibility to Tower Collisions

Nocturnal migrants, such as warblers, vireos, thrushes, and sparrows appear to be more susceptible to tower collisions than other species. Diurnal species most affected appear to be fast-flying species, such as waterfowl, other waterbirds, and raptors. Differences among various taxa of nocturnal migrants in response to tall, lighted structures warrant further research (Avery et al. 1976). Applicable data may provide information regarding family or bird group behavior that may identify measures by which losses of certain species could be reduced. Brewer and Ellis (1958) state that there is a need for direct, quantitative studies on aggregation of migrants and apparent attraction to towers. Understanding those species most susceptible to tower collisions is also critical in the selection of mitigating measures. For example, marking guy wires with bird flight diverters may be of limited value for nocturnal migrants.

4.1.3 *Site Monitoring Approaches*

4.1.3.1 Radar

In an effort to standardize future study methodologies to monitor bird interactions with communication towers, it would be advantageous to establish baseline information on bird densities, movements, altitudes, and behaviors during migration in proximity to tower sites. The use of radar ornithology was briefly discussed relative to the work of Gauthreaux and Belser (2003) and Larkin and Frase (1988). Unpublished study results by Gauthreaux and Belser using "image intensifiers" provide insight into bird behavior at tower sites under various specific conditions. Where feasible, use of radar to determine relative numbers and species of birds proximate to a specific tower site would help to establish this information, particularly relative to the numbers of bird mortalities that could be associated with these migration patterns. Gauthreaux and Belser (2003) provides detailed background information on radar availability and applicability. Specifically, the nationwide network of 151 WSR-88D radars in the contiguous U.S. provide an option to monitor bird migration across the country, although individual tower locations may dictate the feasibility of this approach.

4.1.3.2 Acoustics

Evans (2000) outlines possible acoustical monitoring options, including the use of remote sensors that can transmit information to an offsite, data processing station. This type of system would allow a researcher to obtain data for a large number of towers in regions and flyways noted for avian collisions with towers. This information would be used, among other things, to automatically monitor the frequency of bird concentrations near a tower site, to estimate the numbers of birds, and to test alternative lighting regimes on towers and associated bird responses. In addition, this approach could also provide valuable ancillary information, such as the timing of specific tower surveillance and carcass retrieval, etc.

4.1.3.3 Strike Indicators

A consortium of interested stakeholders is currently involved in the development and testing of the "Bird Strike Indicator" (BSI) as a tool to remotely monitor bird collisions with overhead wires. These entities include:

- Electric Power Line Research Institute
- Western Area Power Administration
- Bonneville Power Administration
- California Energy Commission
- Southern California Edison
- Avian Power Line Interaction Committee
- U.S. Fish and Wildlife Service - Audubon National Wildlife Refuge
- NorthWestern Energy
- Ottertail Power Company

The BSI (Figure 4-1) consists of biaxial accelerometer to monitor line strikes and a wireless radio for communicating with a base station. The BSI sensor includes analog filters to remove very low frequency signals and any 60 Hz noise that might be present. Once a strike is detected, the sensor automatically initiates communication with the base station and reports the date, time, and severity of the impact as peak accelerations encountered in the two axes perpendicular to the line or guy wire. Exceeding the threshold of any of the two perpendicular axes will result in a strike to be detected. After communicating the strike parameters, the sensor transmits the vibration data for each of the two perpendicular axes to be stored in the base station for retrieval or further processing. The monitoring parameters of the BSI can be remotely modified to change the trigger threshold, sampling rate, and number of data points.

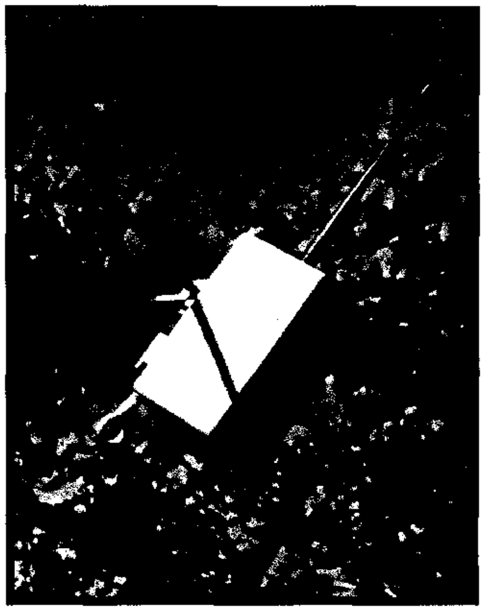

Figure 4-1 Bird Strike Indicator

The base station currently consists of a desktop or laptop computer running the graphical user interface (GUI). In the near future, the base station will consist of a datalogger that can run the developed GUI and solar power supply for application at remote sites where it won't be feasible to use a computer. The GUI collects all the strike data from the BSI sensors and logs them on the base station, as well as displays the signal for quick viewing. The base station GUI monitors the health of all the sensors at least once daily and logs their status. The GUI also can change the monitoring parameters on an individual BSI or all the BSI units simultaneously. A variety of communication options will be available to communicate with the base station for remote access and downloading of the gathered strike data.

This project is a 4-year study to develop, apply, and test the BSI sensor for a series of overhead power lines on the Audubon National Wildlife Refuge in North Dakota. The two primary goals of testing the BSI are to: 1) develop automated monitors to gather information on avian collisions that is difficult or impossible to obtain through direct human observations and 2) evaluate the efficacy of mitigating devices, such as markers and bird diverters designed to reduce avian collisions and associated mortalities with overhead lines or guy wires.

The development of prototype BSI sensor is complete and has successfully undergone laboratory testing at EDM International in Colorado. Field testing of the BSI is presently scheduled to start in spring of 2005. As stated in Section 4.5, EPRI is presently working with the USCG to deploy a BSI on a USCG tower for testing.

Following the development of the BSI, research on developing a "Bird Activity Monitor" (BAM) will be initiated. The BAM would be an intelligent image-based sensing and recording tool to assist with the detailed study of bird interactions with various types of structures. This type of tool would not only identify species that collide with overhead lines or guy wires, it also would record bird behavior as individuals approach the wires and the relative degree of crippling effects (i.e., the number of individuals that may be injured by line collision, but fly off site).

4.1.3.4 Tower Site Studies

At a minimum, it is recommended that access to tower sites be allowed to encourage ongoing dialog between avian researchers and the communication tower industry. This type of agreement would be case-specific and voluntary.

4.1.4 Study Biases

As stated, there is no standard, accepted research protocol for studying communication tower collisions. Dead and injured bird searches can result in an underestimation of mortality if biases are not taken into account. Studies should incorporate the following four main biases:

- Scavenger/Predator Removal Bias
- Crippling Bias
- Searcher Efficiency Bias
- Habitat Bias

Scavenging or predator biases occur when animals remove dead birds before a search. These rates will vary from site to site and by season. In addition rates will vary by species of bird, with smaller birds disappearing more frequently and quickly than larger birds.

A crippling bias occurs when injured birds fall outside the study area and are not detected. Rates vary by bird species and are difficult to obtain. They are calculated as the percentage of birds that collide with a feature and then continue to fly out of the search zone. This bias is least likely to be incorporated into a study because of the effort required to actually observe collisions.

The searcher efficiency bias is based on the ability of a surveyor to detect dead birds. The ability to detect birds is based upon factors such as terrain, vegetation, species of bird, coloration of bird, and the searcher's skill and experience. This bias can be measured by randomly or systematically planting dead birds throughout a study area and measuring the relative detection rate of the searcher.

A habitat bias occurs when there is some part of a study area that simply cannot be searched (e.g., wetland, open water body, dense vegetation). This bias estimate can be very problematic. Habitat biases are restricted to areas of unsearchable habitat interspersed within searchable habitat. This type of bias can sometimes be avoided by designing a study in an area that is completely searchable.

In independent tower studies, determining the bias rates is less critical than in comparative studies. For example, if a single tower is being monitored and the scavenger/predation bias is not determined, the results will represent minimum mortality figures. In comparative studies it is important to understand what the bias rates may be, because their absence will confound any comparisons of mortality to determine if a difference exists between the subject tower and a suitable reference..

4.1.5 Research on Avian Vision

Beason (2000) outlines the current knowledge regarding avian vision and how a bird's perception may be directly associated with collision risks at communication towers. Specific data in this area is lacking, particularly as it pertains to nocturnal neotropical migrants. Future research involving bird vision could greatly enhance the knowledge of how and why birds appear to be attracted to certain lighting regimes.

To implement this approach, the creation of a comprehensive summary of current knowledge on avian vision would be the first step. This literature search and report could guide future research needs. The development of an appropriate study design would build on studies that have been completed to date, incorporating discussions and recommendations from associated avian research scientists. At a minimum, any future research on avian vision should provide information on those species that are most affected by communication tower collisions..

4.1.6 Other Concepts, Approaches, and Recommendations

Larkin (2000) presents a number of ideas in the 1999 Communication Tower workshop for further studies including:

- Wash out the birds' retinas, using a series of flash bulbs on the towers to determine whether a bird without its dark-adapted vision still circles the tower.
- Compare mortality rates at towers in urban locations surrounded by city lighting with more rural towers that have minimal to no light pollution.
- Install mirrors below the lights, so they only shine upwards.
- Paint the guy wires with fluorescent paint and illuminate them.
- Use "coherent radar" to monitor bird movements near the tower structure.
- Implement acoustical monitoring to localize bird calls around the tower.
- Compare the amount of water and fat in a bird carcass as compared to mist netted individuals during the same period to test for physiological stress.
- Experiment with both flashing and red steady lights, alternating and measuring bird behavior.
- Use Doppler radar to record bird strikes on a tower.

4.1.7 Oversight and Research Organization

Finally, a number of discussions have been held (e.g., August 11, 1999 Workshop on Avian Mortality at Communication Towers; February 11, 2004 Communication Tower Working Group Meeting) regarding the value of structuring an oversight research organization for the communication tower industry. Examples of parallel national organizations for other industries include: the Electric Power Research Institute (EPRI), the Avian Power Line Interaction Committee (APLIC), and the National Wind

Coordinating Committee's (NWCC) Avian Subcommittee. The intent would be to establish an organization that could tier off of the efforts and communications to date (e.g., Communication Tower Working Group, RESOLVE) to direct research design, investigate funding options, manage information distribution, encourage communications, and aid in problem and dispute resolution.

4.2 CURRENT STATE-OF-THE-ART MITIGATION METHODS AND APPROACHES

Most avian researchers agree that there are no unambiguous answers on how to avoid avian collisions and mortalities at communication tower sites. It also is commonly agreed that a combination of approaches will likely be required to minimize the collision hazard, particularly for high-risk structures.

No products have been tested specifically on communication tower guy wires to mitigate bird collisions. As discussed in Section 4.1.3, EPRI is presently working with the USCG to deploy a Bird Strike Indicator (BSI) on a USCG communication tower.

Although none of the following devices have been tested on communication towers and their associated guy wires, these devices have had varying levels of success on power lines. Because the success of different devices may be area- and condition- specific, potential applications need to be tested accordingly.

4.2.1 Wire Marking

One of the most effective ways to reduce avian mortality is to mark wires to make them more visible (Beaulaurier 1981). However, from an engineering point of view, wire marking is not always a good solution. Devices that physically enlarge the wire commonly act as wind-catching objects and may increase the risk of wire breaks due to line tension, vibration, and stress loads. The physical attachment of devices also may be problematic, depending on the structure type.

Wire marking has not proved to be the perfect solution for bird collisions and there is no broad agreement among biologists on the success of line marking. However, the effectiveness of some marking methods that target specific bird species and have been implemented for overhead power lines in the electric utility industry is well documented. Wire marking may increase guy wire visibility thereby reducing the collision risk for some birds.

Although several products are available to mark overhead power lines, there have been few rigorous experimental designs to test their effectiveness on electric lines and no studies have been completed to date on communication tower guy wires. Also, very few studies comparing products have been completed. Following is a discussion of the various products available to mark wires and their advantages and disadvantages.

TABLE 4-1

BIRD COLLISION DEVICES AND MANUFACTURERS

Manufacturer	Device	Description	Web Site
Kaddas	Flapper	Swinging Plate	http://www.kaddas.com
BirdMARK	Bird Flight Diverter	Swinging Plate	http://www.pr-tech.com/products/birds/birdsigns.htm
MidSUN	Collision Guard	Swinging Mat	http://www.midsungroup.com
Mission Engineering	Bird Collision Diverter	Swinging Plate	http://www.mission-eng.co.za
Dulmison	Bird Flight Diverter - BFD	Coiled Solid PVC Wire Marker	http://catalog.tycoelectronics.com
Preformed Line Company	Bird Flight Diverter - BFD	Coiled Solid PVC Wire Marker	http://www.preformed.com
Dulmison	Swan Flight Diverter - SFD	Coiled Solid PVC Wire Marker	http://catalog.tycoelectronics.com
Dulmison	Spiral Vibration Dampers - SVD	Vibration Dampers	http://catalog.tycoelectronics.com

4.2.1.1 Flapper

The Flapper (Figure 4-2) was designed in South Africa in partnership with Preformed Line Products, ESKOM, and the Endangered Wildlife Trust (EWT). The Flapper is distributed by Kaddas and is designed to securely grip wires up to a diameter of 0.75 inch with a locking plastic jaw. The Flapper can be installed and removed from the ground. Figure 4-3 shows installation on overhead power lines. The Flapper has been ultraviolet (UV) stabilized; and is available in red, white, and black. Black and white flappers provide maximum contrast.

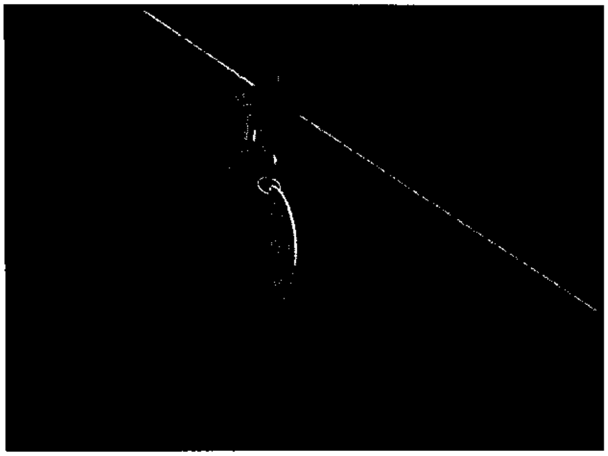

Figure 4-2 White Flapper

The Flapper is used in Africa and is effective at reducing collisions with overhead power lines. However, ESKOM has experienced problems with the device shifting in some the earlier versions (van Rooyen 2000). The EWT recommends two modified ways of attaching the flapper to mitigate this problem:

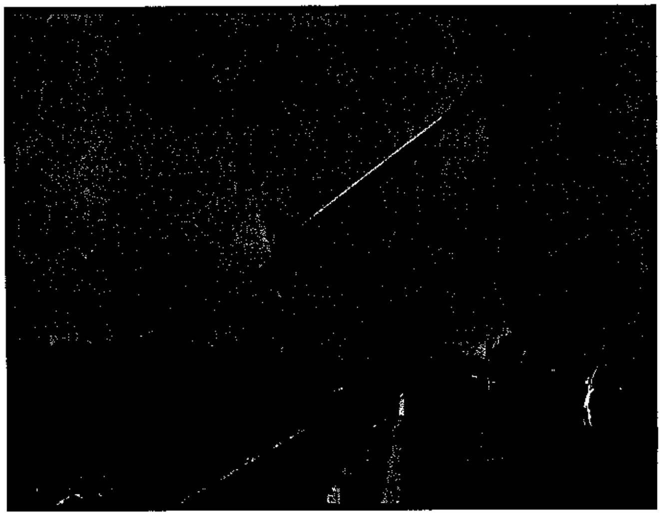

Figure 4-3 Flapper Installation

- Attach the flapper disk (not the clip) to a helical holder (basically a metal wire pigtail), which is then wound around the conductor or guy wire. ESKOM has 2 years of experience of his method on small wires 0.9 inch diameter with no shifting.
- Attach a spiral onto the

conductor and then attach the flapper by its hook to the spiral. This has the advantage of making the line even more visible as the device is now bigger. ESKOM has not experienced spirals shifting since implementing these measures.

The newest Flapper version is attached by a clamp arrangement activated by a (nonmetallic) screw eye, which can be installed using a shotgun stick. According to the distributor, this unit when properly applied, will not shift and move on the wire. The manufacturer also recommends using silicone adhesive on the clamp.

There are two versions of the Flapper, one is attached with a ratcheted clamp, and the other is installed with a breakaway composite screw using a hotline stick. The Flapper is available with a luminescent paint that will glow in low light situations. The color of devices plays an important role in reducing collisions (Kreithen 1996).

The advantage of the Flapper is the movement of the swinging plate helps make a line more visible than simply increasing the line profile. The effectiveness of the Flapper has been scientifically tested in South Africa, and preliminary data show that the Flapper is effective in reducing bustard and crane collisions (van Rooyen 2000; Anderson 2001). However, Flapper applications to communication towers would primarily target diurnal birds and would not likely reduce the collision risk for nocturnal migrants. Other operational issues to consider include possible vandalism, since marking devices resembling targets might create problems. The potential for devices slipping on hard to access tower guy wires also is of concern and would need to be tested.

4.2.1.2 BirdMARK Bird Flight Diverter

The BirdMARK (Figure 4-4) is distributed by P&R Industries and is designed to securely grip wires up to a diameter of 2.5 inches with a strong spring-loaded clamping jaw. The clamping jaw also is used with several other P&R products designed specifically for overhead lines. The BirdMARK is presently being used in England and Ireland on power lines.

The BirdMARK can be installed and removed from the ground. The manufacturer claims the BirdMARK will stay in position even in a Force 8 gale. The swinging roundel is available in either orange or red-and-white.

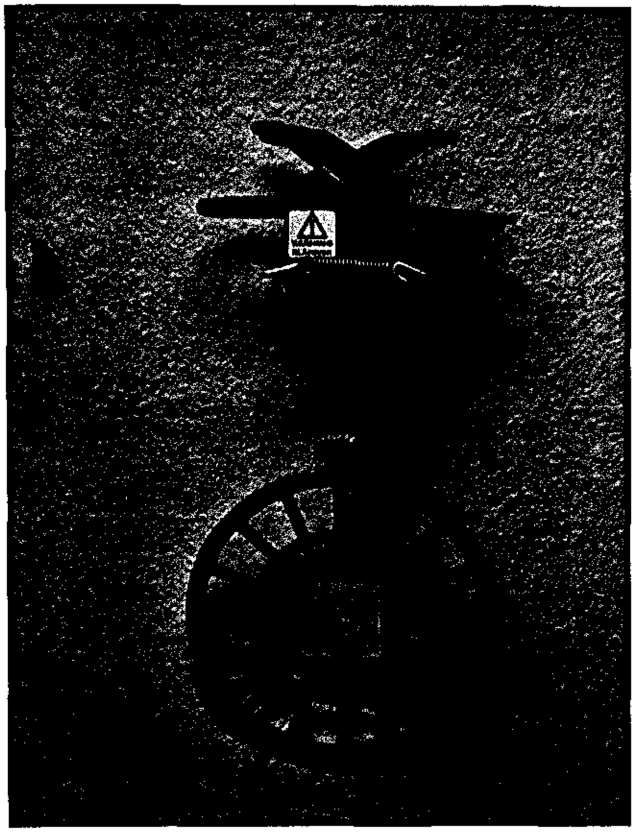

Figure 4-4 BirdMARK Bird Flight Diverter

As discussed for the Flapper, the advantage of the BirdMARK is the movement of the swinging plate makes a wire more visible than simply increasing the line profile. However, vandalism can be a problem. Unfortunately, no studies on the effectiveness of the BirdMARK were found in the scientific literature although it would appear the device should be similarly effective as the Flapper.

Recently this product line has been expanded to include the FireFly, which may be more applicable to reducing nocturnal collisions with communication tower guy wires. The FireFly uses the same clamp as the BirdMARK but the circular plate has been replaced with a rectangular plate. The rectangular plate includes a reflective and fluorescent reflective plate for low light and nighttime conditions (Figure 4-5 and Figure 4-6).

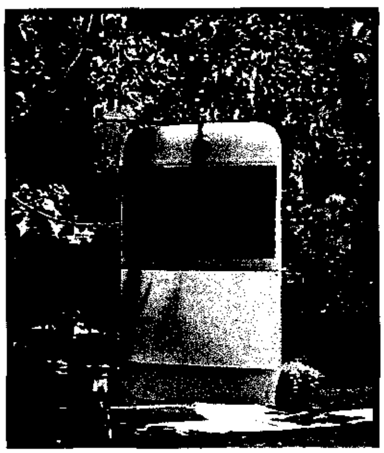

Figure 4-5 FireFly During the Day

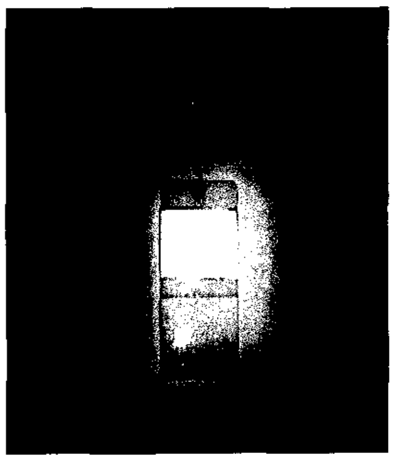

Figure 4-6 FireFly at Night

The FireFly's clamp has been designed to be installed on communication tower guy wires; however, this product has not been tested.

Mission Engineering and MIDSUN Company also have recently introduced their own versions of swinging devices to prevent collisions (Figure 4-7). However, no data are currently available on their effectiveness.

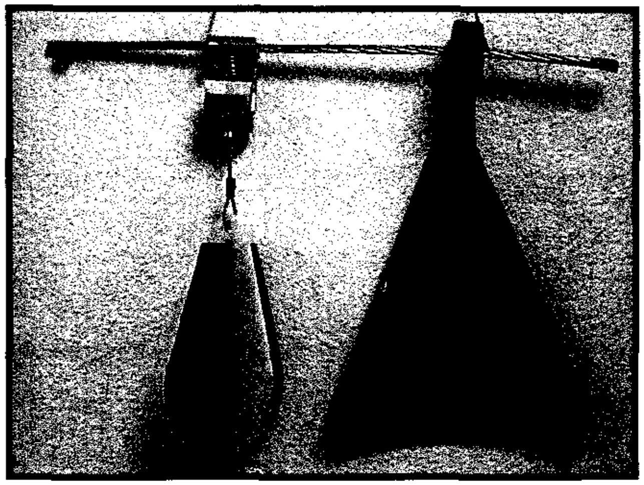

Figure 4-7 Mission Engineering (left) and MIDSUN (right) Bird Diverters

4.2.1.3 Bird Flight Diverter

The Bird Flight Diverter (BFD) was developed in Europe during the 1970's (Figure 4-8). The BFD is made from a high-impact, standard gray PVC and is UV stabilized.

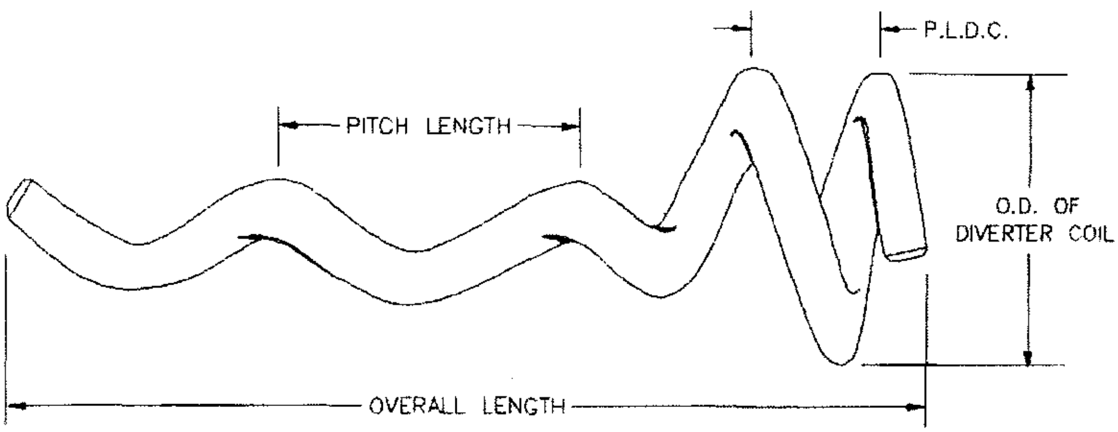

Figure 4-8 Bird Flight Diverter Manufactured by Dulmison. Made from High-impact PVC and is UV Stabilized.